The Wheelerian Foundation Initiative: Reorienting Fundamental Physics Toward Quantum Origins and Informational Ontology

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The Wheelerian Foundation Initiative: Reorienting Fundamental Physics Toward Quantum Origins and Informational Ontology calls for a transformative shift in how foundational physics is conceived, funded, and pursued. Rooted in the visionary ideas of physicist John Archibald Wheeler, this initiative challenges the dominance of classical paradigms by proposing a research agenda centered on the quantum vacuum, information as ontology, observer-participancy, and emergent spacetime. While mainstream physics continues to invest heavily in large-scale confirmation projects grounded in General Relativity, the Wheelerian perspective argues that true breakthroughs will arise from exploring the deeper informational substrate of reality—where geometry, matter, and even causality may emerge from quantum processes. This paper outlines the conceptual foundations, experimental priorities, infrastructure strategies, and policy recommendations required to establish a new kind of scientific research ecosystem. It advocates for high-risk, high-reward inquiry, interdisciplinary collaboration, and intellectual openness, inviting institutions, funders, and researchers to embrace uncertainty and reengage with the deepest unresolved questions in physics. The Wheelerian Initiative is not a rejection of science as it is—it is a bold invitation to rediscover science as it could be.

Keywords: Wheelerian physics, quantum vacuum, informational ontology, emergent spacetime, quantum foundations, participatory universe, quantum measurement, delayed-choice experiments, Casimir effect, quantum noise, it from bit, foundational physics, physics of observation, John Archibald Wheeler, quantum information, quantum ontology, quantum eraser, measurement problem, high-risk research, paradigm shift. A collaboration with GPT-4o. CC4.0.

I. Executive Summary

This white paper proposes the launch of a bold new scientific initiative: the Wheelerian Foundation Initiative, a coordinated research effort to investigate the foundational quantum structure of reality through the lens of quantum information, vacuum fluctuations, and the observer's role in physics. Rather than continue to invest disproportionately in large-scale instruments aimed at refining existing classical theories—most notably General Relativity—this initiative seeks to reorient physics toward the unresolved quantum questions that underpin the very fabric of the universe.

Purpose of the White Paper

The purpose of this white paper is to argue for the establishment of a new research paradigm rooted in the ideas of John Archibald Wheeler. Specifically, it advocates for funding and institutional support for theoretical and experimental investigations into quantum noise, the quantum vacuum, emergent spacetime, and the role of information and observation in physical law. It aims to demonstrate that such research—although riskier and more speculative than traditional projects—has the potential to trigger transformative breakthroughs in our understanding of nature.

Rationale for Rethinking Current Scientific Funding Priorities

In recent decades, a growing share of scientific funding has been directed toward projects designed to confirm known theories to higher levels of precision. Instruments such as the Einstein Telescope and other gravitational wave observatories are excellent examples of high-investment projects aimed primarily at verifying predictions of General Relativity. While these instruments yield important data, they operate within a theoretical framework whose known incompleteness—the lack of unification with quantum theory—is a glaring limitation. The continued allocation of massive funds to legacy frameworks risks stagnation and overlooks opportunities for revolutionary insight.

Moreover, the disconnect between General Relativity and Quantum Mechanics is not a minor issue—it represents the most significant gap in modern physics. Funding programs that bypass this foundational problem in favor of precision

confirmation run the risk of deepening theoretical ruts. If the conceptual architecture of physical law is undergoing a phase transition, as many suspect, then research must be directed at the quantum edge where such transitions occur.

Introduction to the Wheelerian Perspective

The Wheelerian perspective derives from the work and philosophical legacy of physicist John Archibald Wheeler, who proposed that physical reality is fundamentally quantum-informational in nature. His central idea—"It from Bit"—suggests that the properties of matter, energy, space, and time emerge from informational processes governed by quantum logic. Wheeler championed the role of the observer, the concept of participatory reality, and the possibility that the universe itself is shaped, in part, by acts of measurement.

This vision opens an expansive and largely unexplored territory: the quantum domain not merely as a substrate for particle interactions, but as the source of physical law itself. It suggests that to understand gravity, time, and even causality, we must first understand the informational and participatory structure of the quantum vacuum. A Wheelerian initiative would thus redirect attention away from high-cost instruments built to validate well-established classical theories and toward targeted experiments and models designed to probe where classical physics breaks down and deeper coherence might be found.

In short, this white paper argues for a generational shift in how science prioritizes and funds discovery—toward a frontier where theory, measurement, and metaphysics converge.

II. The Current Landscape: Limitations of Legacy Paradigms

Modern physics has been shaped by two towering achievements: General Relativity (GR) and Quantum Mechanics (QM). Each framework has produced an array of testable predictions and technological advancements. Yet, for all their empirical success, these theories remain theoretically incompatible, and the failure to unify them represents an existential challenge to the completeness of

our physical worldview. This section outlines the empirical triumphs and inherent limitations of General Relativity, the fundamental disconnect between GR and QM, and the strategic shortcomings of contemporary large-scale scientific investments—particularly those that prioritize confirmation over foundational exploration.

Overview of General Relativity's Empirical Success and Limitations

Since its introduction in 1915, Einstein's theory of General Relativity has withstood over a century of experimental tests. From the perihelion precession of Mercury to the deflection of starlight during solar eclipses, from the precise predictions of gravitational time dilation used in GPS technology to the detection of gravitational waves in 2015 by LIGO, General Relativity has proven itself as the most accurate classical description of gravity. Its geometric model of spacetime curvature, driven by mass and energy, continues to provide the foundation for our understanding of large-scale structures in the universe.

However, this success masks a deeper problem: General Relativity cannot account for the quantum behavior of matter and energy. It breaks down at singularities such as the centers of black holes and the origin of the Big Bang. It cannot describe phenomena at Planck-scale energies, nor does it incorporate the probabilistic nature of quantum measurement or the non-local correlations evident in quantum entanglement. Its classical, continuous treatment of spacetime contrasts sharply with the discrete, probabilistic character of quantum theory.

Disconnect Between GR and Quantum Mechanics

Quantum Mechanics, born around the same time as General Relativity, governs the behavior of particles, fields, and information at atomic and subatomic scales. While GR treats spacetime as a smooth manifold, QM is governed by wavefunctions, uncertainty, and probabilistic outcomes. Despite various efforts—string theory, loop quantum gravity, causal dynamical triangulations—no theory of quantum gravity has been experimentally validated. The two frameworks operate in parallel but do not intersect coherently.

The conflict is not merely mathematical but ontological. GR describes a deterministic universe governed by geometric necessity, while QM describes a probabilistic cosmos influenced by measurement and uncertainty. There is no shared language between these theories to describe a photon entering a black hole or the behavior of spacetime near quantum singularities. This disconnect suggests that at least one, if not both, theories are incomplete or emergent—not fundamental.

Critique of Large-Scale, Confirmation-Focused Instruments (e.g., Einstein Telescope)

Despite this foundational crisis, physics continues to funnel resources into projects like the Einstein Telescope, a third-generation gravitational wave observatory designed to confirm and extend our observations of gravitational waves. While such a project is technically impressive and may provide new astrophysical data, its theoretical framework remains firmly grounded in classical General Relativity.

This type of initiative embodies a confirmation-focused mindset: design instruments to test known predictions with greater precision, rather than to challenge or reformulate the theory itself. While marginal gains in measurement accuracy are valuable, they do not address the open chasm between GR and QM. The Einstein Telescope, for example, is unlikely to yield insights into quantum gravity, the origin of spacetime, or the informational structure underlying physical law. Its scale and cost make it emblematic of a funding culture that prioritizes validation over speculation, and engineering over fundamental inquiry.

The Cost-Risk Imbalance in Contemporary Physics Funding

Large-scale projects like the Einstein Telescope often require multi-billion-euro budgets, international cooperation, and decades of planning. Such investments carry not only financial costs but intellectual opportunity costs. By dedicating vast resources to confirmatory science, the physics community risks crowding out alternative, potentially paradigm-shifting research—particularly those investigating the quantum origins of spacetime, the role of the observer, or the informational nature of physical reality.

This imbalance reflects an institutional bias toward predictability and risk-aversion, rather than a true openness to disruptive innovation. As Thomas Kuhn observed in *The Structure of Scientific Revolutions*, science in its "normal" mode tends to reinforce prevailing paradigms. When funding is allocated primarily to reinforce those paradigms, the result is a stabilization of the status quo, not the advancement of fundamental understanding.

In summary, while General Relativity remains a robust theory in its domain, it cannot be the endpoint of physics. Continued investment in projects designed only to extend its observational reach, without addressing its incompatibility with quantum theory, represents a narrowing of scientific vision. The Wheelerian Foundation Initiative aims to correct this imbalance by redirecting attention—and resources—toward the deepest and most unresolved questions at the heart of modern physics.

III. Wheeler's Vision Revisited

As the scientific community confronts the impasse between General Relativity and Quantum Mechanics, it becomes necessary to reexamine the ideas of those thinkers who foresaw the limitations of classical frameworks and anticipated a deeper ontological shift. Among them, John Archibald Wheeler stands out—not only for his technical contributions to physics, including nuclear fission, wormholes, and black hole thermodynamics—but for his provocative and prescient philosophy of physics. His ideas, long treated as speculative metaphors, now offer a viable foundation for a new research direction: one that places information, observer-participation, and quantum structure at the core of physical law.

John Archibald Wheeler's Legacy: "It from Bit," Participatory Universe, Quantum Foam

Wheeler's most famous conceptual slogan, "It from Bit," captures the essence of his late-career worldview: that every physical entity (the "it") arises from acts of observation and yes/no informational distinctions (the "bit"). In this framing, the

universe is not built from matter or fields, but from fundamental acts of measurement—interactions that produce outcomes. According to Wheeler, the universe as we know it is not a passive, external object but a participatory system in which observation creates reality. This was not an abstract idealism but a proposal grounded in the interpretive dilemmas of quantum mechanics, especially the measurement problem.

He also introduced the idea of quantum foam, a turbulent structure of spacetime at the Planck scale, where geometry itself is uncertain and fluctuating due to quantum effects. At this scale, conventional notions of space and time dissolve, and Wheeler suspected that a new substrate—something pre-geometric and informational—would be required to understand reality. The foam, to him, was not merely a manifestation of quantum uncertainty, but a threshold domain where the classical and quantum merge and from which spacetime and law might emerge.

The participatory universe was Wheeler's answer to the apparent paradoxes of quantum mechanics: the observer is not outside the system but part of the system's unfolding reality. He envisioned a self-excited circuit, where the universe gives rise to observers who in turn help bring the universe into being. Though radical, this concept echoes with contemporary ideas in quantum cosmology and holography, where boundary conditions and information play constitutive roles.

Conceptual Foundation for the Wheelerian Research Direction

The Wheelerian research direction begins with the premise that information—not matter or energy—is the most fundamental element of physical theory. It takes seriously the proposition that measurement is not merely a practical procedure but a foundational act, and that the physical universe emerges through such acts. Rather than accept spacetime, particles, or fields as primitives, the Wheelerian view treats these as emergent phenomena—the result of a deeper informational substrate governed by logic, symmetry, and interaction.

This leads naturally to a suite of research questions that are both philosophically profound and empirically addressable:

- What is the quantum vacuum, really?
- Is quantum noise structured?
- Can the act of measurement be modeled as a fundamental physical process rather than an interpretive boundary?
- Does spacetime emerge from patterns of entanglement or informational connectivity?
- Can a pre-geometric substrate account for gravity, inertia, or even time?

The Wheelerian approach encourages an ontology of process rather than substance, and suggests that causality, geometry, and even physical law are emergent, not fixed. In this sense, Wheeler's ideas form the conceptual core of a 21st-century research program that aims not to refine existing paradigms but to dissolve and reframe them.

Differentiation from Mainstream Quantum Gravity Programs

While string theory and loop quantum gravity (LQG) are often framed as attempts to unify GR and QM, they remain largely conservative in structure. Both retain many of the classical assumptions of the physics they seek to unify:

- String theory posits tiny vibrating objects in a higher-dimensional spacetime, and relies on mathematical consistency, supersymmetry, and often non-falsifiable hypotheses. Though elegant, it is heavily reliant on prior mathematical structures, and it remains unclear whether it describes anything physically real.
- Loop quantum gravity, on the other hand, begins with a more direct quantization of spacetime and suggests that space is granular at the Planck scale. While more modest and concrete than string theory, LQG still presupposes spacetime as a background or a quantizable object, and has struggled to produce testable predictions.

Both frameworks, despite their technical sophistication, preserve the metaphysical assumptions of the classical tradition: a fixed set of entities evolving in a deterministic or probabilistic framework. Neither seriously engages with the role of the observer, nor with the idea that information is primary and geometry is emergent.

In contrast, the Wheelerian perspective begins with the assumption that no entity or geometry exists independently of interaction—and that these interactions are themselves discrete, informational, and participatory. In doing so, it invites a different kind of theorizing, one rooted in digital ontology, category theory, quantum information science, and experimental designs probing the vacuum and measurement.

The Wheelerian Foundation Initiative thus represents not a competitor to string theory or LQG, but a reconceptualization of what physics is. It invites us to treat quantum noise as signal, to explore the limits of causality and observation, and to reimagine science not as the measurement of what is, but as the active participation in what becomes.

IV. Strategic Research Domains of the Wheelerian Initiative

The Wheelerian Foundation Initiative proposes a systematic and coordinated research program that departs from the traditional path of unifying General Relativity and Quantum Mechanics through mathematical overlays. Instead, it approaches the problem from below—starting not with established constructs like spacetime and force fields, but with the more foundational phenomena that precede them. This section outlines five strategic research domains that together constitute the core of the Wheelerian approach. Each domain is chosen for its potential to illuminate the informational and participatory substrate that Wheeler believed underlies physical law.

Quantum Vacuum Studies

The quantum vacuum is not empty. Rather, it is a seething medium of virtual particles, zero-point energy, and fluctuating fields—a domain often treated as a technical artifact but in fact representing a foundational mystery. Wheeler's vision of "quantum foam" posits that spacetime itself dissolves into turbulence at the Planck scale. This research domain seeks to rigorously investigate the structure and behavior of the vacuum, both theoretically and experimentally.

Key areas of focus include:

- Zero-point fluctuations: Analyzing how vacuum energy might give rise to measurable forces or geometric effects.
- Casimir effects: Enhancing experimental sensitivity to detect subtle forces arising from vacuum field constraints.
- Vacuum engineering: Exploring whether controlled manipulations of boundary conditions can produce energy gradients or extract information.
- Refinements in measurement: Designing ultra-sensitive setups capable of detecting quantum foam signatures or deviations from flatness in small-scale spacetime.

The goal is to test whether the vacuum serves merely as a backdrop to physics or is itself a generative substrate of physical reality.

Quantum Information as Ontology

Rather than treating information as a tool for describing systems, this research domain explores the possibility that information is what systems are made of. Wheeler's assertion that "It from Bit" suggests a radical ontological inversion: the classical world of objects and events arises from an informational layer in which quantum logic and binary distinctions give rise to apparent continuity and causality.

This domain will pursue:

- Information-theoretic derivations of physical law: Can conservation laws, symmetry principles, or quantum field behavior be derived from informational axioms?
- Reformulating particles and fields: Modeling matter and energy as emergent from networks of informational relations or logic operations.
- Foundational computing models: Utilizing quantum computing and cellular automata as testbeds for simulating physical emergence from informational rules.
- Linkages to category theory and topos theory: Employing mathematical tools capable of describing a universe in which relationships precede objects.

The ultimate aim is to reconstruct physics not from geometry or energy, but from the syntax of interaction and information.

Observer-Participancy and the Measurement Problem
The measurement problem in quantum mechanics—the question of how and when a wavefunction collapses into a definite outcome—remains unresolved. Wheeler pushed this further, suggesting that observers play an active role in the generation of physical reality. This domain seeks to explore the boundaries of observation, measurement, and even consciousness, through both theoretical reflection and experimental design.

Areas of inquiry include:

- Delayed-choice experiments: Further refining Wheeler's own experiments to test the influence of future observation on past events.
- Quantum eraser setups: Exploring the reversibility of measurement and the conditions under which information is retained or destroyed.

- Consciousness and measurement: Carefully constructed protocols (with ethical oversight) to test whether conscious awareness plays any role distinguishable from automated detection.
- Participatory models of cosmology: Considering how quantum observation may be involved in the emergence of large-scale structure or physical law itself.

This research challenges the boundary between subject and object, and suggests a physics of engagement, rather than passive observation.

Quantum Noise as Foundational Signal

In most scientific contexts, noise is an obstacle—random, unpredictable, and disruptive. The Wheelerian Initiative reverses this framing: quantum noise may be the raw material of order. If quantum fluctuations are the medium from which spacetime and law emerge, then they are not error—they are signal before structure.

Research activities will include:

- Reinterpreting decoherence: Understanding decoherence not merely as environmental entanglement but as a bridge between quantum and classical regimes.
- Analyzing stochasticity: Identifying lawful patterns in quantum randomness—fluctuation symmetries, invariant distributions, or informational gradients.
- Entropy as architecture: Exploring whether thermodynamic entropy, especially in the vacuum, plays a constructive role in system evolution.
- Linking quantum noise to emergence: Investigating how fluctuations might seed the formation of particles, fields, and geometry itself.

This work redefines randomness not as ignorance but as the language of potentiality, spoken before order arises.

Emergent Spacetime

The assumption that spacetime is fundamental has increasingly come under scrutiny. The Wheelerian Initiative places the emergence of spacetime from quantum processes at the center of its research agenda. If space and time are not primary but derived from entanglement patterns, informational connectivity, or topological logic, then physics must be reconstructed from the ground up.

Key areas of exploration include:

- Entanglement geometry: Extending research that links quantum entanglement with spatial distance, such as in AdS/CFT correspondence and tensor networks.
- Causal emergence: Investigating how causality itself may be a result of network connectivity or symmetry-breaking in informational substrates.
- Pre-geometric models: Developing frameworks where no spatial variables are initially assumed, and spacetime arises as an ordering of interactions.
- Simulating spacetime birth: Using computational methods to model how coherent geometry might emerge from informational or energetic turbulence.

The long-term goal is to discover what spacetime is made of, or whether it is simply the perceptual projection of deeper quantum-informational processes.

Taken together, these five domains represent a research program as intellectually daring as the Copenhagen interpretation once was—and as potentially revolutionary. They do not presume that existing physics is wrong, but that it is a phase of understanding built upon deeper processes we have only begun to glimpse. The Wheelerian Foundation Initiative offers a structure for exploring those processes systematically, rigorously, and with the humility to ask what physics really is.

V. Proposed Infrastructure and Methodologies

To pursue the ambitious research agenda of the Wheelerian Foundation Initiative, a new kind of scientific infrastructure is required—one that is nimble, decentralized, interdisciplinary, and oriented toward fundamental exploration rather than technological iteration. Unlike billion-euro megaprojects that require vast bureaucracies and decades of lead time, this initiative is designed around modular, rapid-deployment scientific platforms that can adapt quickly to new theoretical insights, experimental results, and conceptual breakthroughs.

The following infrastructure and methodological components are essential to support this initiative:

Small- to Medium-Scale Experimental Platforms
The questions posed by the Wheelerian Initiative—concerning quantum noise, vacuum fluctuations, and the emergence of spacetime—do not require vast facilities like particle colliders or gravitational observatories. Rather, they demand precision, sensitivity, and novel design, often on the scale of tabletop experiments or room-sized instrumentation. These platforms can be distributed across universities, independent research institutes, and even private laboratories, making the initiative both cost-effective and scalable.

Key examples include:

- Casimir force detection labs, utilizing nano- and micro-scale setups to probe vacuum interactions.
- Quantum optics and delayed-choice experiment stations, capable of exploring the foundations of measurement and entanglement.
- Cryogenic noise laboratories, investigating low-temperature quantum fluctuation regimes.
- Quantum simulation environments, where condensed matter systems or qubits are used to model emergent physical behaviors.

The objective is to enable fast-turnaround, hypothesis-driven experimentation that can iterate in concert with evolving theoretical work.

Interdisciplinary Collaborations: Physics, Philosophy, Information Science
A defining feature of the Wheelerian Initiative is its interdisciplinary DNA. The conceptual landscape Wheeler envisioned cannot be fully navigated using the tools of physics alone. Foundational issues around information, observation, emergence, and ontology straddle the boundary between science and philosophy—and increasingly intersect with developments in information theory and quantum computing.

To this end, the initiative will facilitate collaborations among:

- Theoretical physicists, particularly those working in quantum foundations, emergent gravity, and information-based models.
- Philosophers of science, particularly those focused on metaphysics, epistemology, and the interpretation of quantum mechanics.
- Quantum information theorists and computer scientists, working on topics such as entanglement entropy, algorithmic complexity, and the physical limits of computation.
- Experimental physicists, with expertise in precision measurement, noise analysis, and quantum optics.

Rather than sequester these disciplines into parallel silos, the Wheelerian Initiative will integrate them into common research clusters, where conceptual problems are co-investigated from multiple vantage points. This structure mirrors the collaborative nature of the questions themselves, which defy neat disciplinary boundaries.

Theoretical Fellowships and Agile Research Grants

The Wheelerian Foundation Initiative recognizes that conceptual progress often precedes technical implementation. To support high-risk, high-reward theoretical work, the initiative will offer individually tailored fellowships for researchers pursuing novel approaches to core questions in quantum foundations, information ontology, and emergent spacetime.

Complementing these fellowships, the initiative will launch an agile grant program—designed to fund small teams or individual investigators on short notice. These grants will emphasize:

- Rapid experimentation and feedback between theory and experiment.
- Non-traditional research outputs, such as simulation-based proofs of concept or formal philosophical argumentation.
- Inclusivity of unconventional thinkers, including those working outside traditional academic frameworks.

This funding model avoids the rigidity of long-cycle grant competitions and allows the initiative to respond dynamically to emerging insights and new directions.

Open-Access Simulations and Data Sharing Across Global Teams

As Wheeler himself suggested, reality may be more participatory than it appears. The Wheelerian Initiative reflects this spirit by committing to radical openness in its research outputs, methodologies, and intellectual architecture. All theoretical models, data sets, simulation environments, and experimental protocols developed under the initiative will be made open-access by default, allowing global participation and scrutiny.

This infrastructure includes:

- Cloud-based simulation platforms for testing emergent spacetime models, vacuum fluctuation dynamics, and quantum information architectures.
- Data repositories and version-controlled notebooks, facilitating real-time collaboration between theorists and experimentalists.
- Open protocol registries, allowing independent labs to replicate and modify experimental designs in pursuit of new insights.
- Global idea exchange forums, where researchers from across the world—regardless of affiliation—can propose, critique, and refine new concepts in foundational physics.

By enabling shared access to intellectual and experimental tools, the initiative amplifies its collective intelligence and avoids the siloing effects that have plagued earlier waves of theoretical and experimental physics.

In sum, the infrastructure and methodologies of the Wheelerian Foundation Initiative reflect its philosophical commitments: decentralization over centralization, emergence over engineering, openness over secrecy, and interdisciplinarity over specialization. Its structure is not an afterthought but a direct expression of the principles it seeks to explore—that the universe, like science itself, may be best understood not through imposed order but through participatory emergence.

VI. Cost-Benefit Analysis

In an era of tightening budgets, increasing global instability, and pressing demands on public resources, every large-scale scientific investment must be evaluated not only in terms of its technical merit but in terms of its epistemic return—that is, its potential to generate fundamentally new understanding. The Wheelerian Foundation Initiative is proposed as a cost-effective, intellectually disruptive

alternative to traditional mega-projects in physics, many of which aim to refine our current understanding rather than to challenge or extend its deepest assumptions. This section outlines a comparative cost-benefit analysis to demonstrate the strategic advantages of pursuing foundational research with modest infrastructure, as opposed to funding projects aimed at confirmation of legacy paradigms.

Comparison with Billion-Euro Projects (e.g., LIGO, Einstein Telescope)

Projects like LIGO and the proposed Einstein Telescope represent the dominant model of modern “big science.” LIGO cost over $1 billion to build and operate, while the Einstein Telescope is projected to exceed €1.9 billion, not including long-term maintenance, data processing, and international coordination expenses. These facilities are technically extraordinary and have delivered valuable results—most notably, LIGO's 2015 detection of gravitational waves, which confirmed a century-old prediction of Einstein’s General Relativity.

However, these projects are based on known physics. Their central function is not to test new paradigms but to increase precision and expand observational reach within established theoretical frameworks. They are built to detect what the theory already expects to find—binary black hole mergers, neutron star collisions, and other relativistic phenomena. While this has extended our astrophysical knowledge, it does not address the foundational rift between GR and QM, nor does it offer a clear path toward a unified theory.

Moreover, these mega-projects carry immense opportunity costs. The capital, human labor, and institutional focus required to plan and operate such projects tends to crowd out smaller-scale efforts that might pursue riskier, more speculative lines of inquiry. Their very size imposes a bureaucratic and conservative orientation, where novelty is disincentivized and paradigm-challenging work is difficult to justify within a rigid performance-evaluation structure.

Benefits of Nimble, Foundational Research at a Fraction of the Cost

The Wheelerian Foundation Initiative advocates for a distributed, modular approach to foundational physics that can be executed at a fraction of the cost of large-scale observatories. A full decade of experimental and theoretical progress within this initiative could be funded for under €100 million globally—less than 5% of the projected cost of the Einstein Telescope.

The advantages of this model are multifold:

- Lower barrier to entry: Smaller labs and institutions around the world can participate, democratizing access to advanced foundational research.
- Rapid iteration: Hypotheses can be tested, refined, or abandoned quickly, without the inertia of long construction timelines.
- Conceptual agility: Theoretical insights can be acted upon without the need for multi-year funding cycles or construction milestones.
- Intellectual diversity: Researchers are encouraged to pursue unconventional lines of inquiry, drawing from philosophy, computer science, mathematics, and quantum foundations.

This model is not a cost-cutting compromise. It is a strategic recalibration: a commitment to exploring where theory is weakest, rather than continuing to validate what is already well-understood.

Long-Term Implications: Paradigm Shift vs. Incremental Confirmation

Perhaps the most important distinction in this analysis is between two very different kinds of scientific progress:

1. Incremental confirmation improves measurement precision within known frameworks. It deepens our confidence but rarely reshapes our worldview.
2. Paradigm shifts, by contrast, often arise from anomalies, conceptual re-evaluations, and exploratory work at the theoretical frontier.

The Wheelerian Initiative is designed to foster the second kind of progress. Its goal is not simply to refine or defend existing theories, but to reimagine the foundations on which those theories are built. By engaging directly with questions about the quantum vacuum, the role of the observer, and the informational basis of reality, it aims to catalyze a new theoretical synthesis—one that can finally bridge the divide between relativity and quantum theory, and perhaps even point the way toward a post-spacetime understanding of physics itself.

The historical record supports this strategy. Breakthroughs such as quantum mechanics, relativity, and the standard model did not emerge from large collaborations attempting to confirm previous ideas. They came from small groups or individuals working at the conceptual edge, often in defiance of accepted thinking. The Wheelerian Initiative seeks to recreate the conditions that made such breakthroughs possible—not by nostalgia, but by recognizing that science must remain open to its own reinvention.

In sum, while traditional large-scale instruments like the Einstein Telescope are not without merit, their high cost and narrow conceptual scope make them increasingly unsuited to address the deepest challenges in theoretical physics. The Wheelerian Foundation Initiative offers a compelling alternative: a high-leverage, low-cost research ecosystem aimed at catalyzing a new understanding of reality itself.

VII. Policy Recommendations

The Wheelerian Foundation Initiative requires not only a reorientation of scientific priorities but a corresponding shift in policy frameworks that govern how research is funded, structured, and evaluated. To unlock the full potential of a foundational, high-risk program focused on the quantum basis of physical reality, governments, research councils, private foundations, and academic institutions must break from entrenched funding models that favor scale, predictability, and conformity to

legacy paradigms. This section outlines three key policy recommendations designed to support a generative ecosystem for Wheelerian research.

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1. Allocation of Public Science Funds for High-Risk, High-Reward Foundational Physics

One of the most pressing policy needs is to establish a dedicated funding stream within national and international science agencies—such as the National Science Foundation (NSF), European Research Council (ERC), and equivalents in Asia and South America—for high-risk, high-reward theoretical and experimental research in foundational physics.

This funding should prioritize:

- Conceptual novelty over project scale: Proposals that challenge prevailing assumptions about space, time, measurement, and information should be evaluated for intellectual boldness, not just feasibility.
- Short-term exploratory grants: Small grants (~€100,000–€500,000) with one- to two-year horizons can allow for rapid development of speculative ideas without long bureaucratic delays.
- Tiered funding progression: Promising results from short-term work can trigger eligibility for larger, multi-year grants that scale up successful concepts.
- Institutional neutrality: Funding should be available across universities, independent think tanks, private laboratories, and non-traditional research collectives to avoid geographic or institutional bias.

Such an allocation mechanism would reflect the understanding that paradigm-defining insights often emerge from outside the mainstream, and that fostering them requires institutional courage and intellectual pluralism.

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2. Creation of Dedicated Wheelerian Foundation Research Centers

To consolidate progress, foster community, and provide long-term stability, the establishment of dedicated research centers focused explicitly on Wheelerian themes is essential. These centers would function as interdisciplinary hubs that integrate quantum physics, information theory, philosophy of science, and computational modeling under a unified research mandate.

These centers should be designed to:

- Host resident research teams of physicists, philosophers, and information theorists working on cross-cutting problems such as emergent spacetime, quantum ontology, and the role of observation.
- Support rotating fellowships for visiting researchers and sabbatical scholars seeking time away from traditional institutions to pursue foundational work.
- Build experimental platforms in quantum optics, vacuum studies, and quantum simulation to test Wheelerian hypotheses.
- Hold annual or semi-annual retreats and conferences to promote idea exchange, critical discussion, and collaboration on shared research questions.

Unlike national laboratories or university departments tied to specific missions or educational goals, these research centers would function as dedicated incubators of intellectual risk-taking. They would not simply generate results but cultivate new ways of asking questions, aligning closely with Wheeler's belief that physics must evolve its very methods if it is to uncover new truths.

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3. Engagement with Early-Career Researchers Through Challenge-Based Funding Models

One of the greatest untapped resources in contemporary science is the creativity of early-career researchers, many of whom are intellectually capable of advancing

foundational questions but are locked into narrow, career-driven research pathways. To engage this demographic, the Wheelerian Initiative proposes the implementation of challenge-based funding models tailored for postdoctoral researchers, graduate students, and independent investigators.

This model would include:

- Thematic research challenges: Calls for proposals centered on big, unanswered questions—e.g., “Can geometry emerge from entanglement?”, “What does a measurement do to the vacuum?”, “Is quantum noise structured?”
- Minimal credential barriers: Proposals could be submitted by researchers without formal academic positions, as long as the ideas are sound and well-articulated.
- Peer-led review panels: To reduce bias and foster intellectual diversity, proposals would be evaluated by interdisciplinary panels including early-career scientists and philosophers.
- Seed-funding grants: Modest initial awards (~€10,000–€50,000) could support feasibility studies, simulations, or thought experiments.
- Mentorship and visibility: Grant recipients would gain access to senior mentors, presentation opportunities, and networking platforms through affiliated Wheelerian Research Centers.

This approach democratizes foundational inquiry and positions the next generation of thinkers at the frontier of physics. It recognizes that paradigm change often begins not from established institutions but from minds still free to imagine.

Taken together, these policy recommendations form the institutional backbone of the Wheelerian Foundation Initiative. They signal a shift not only in what kinds of scientific questions are prioritized, but in how science itself is structured, incentivized, and valued. If the next great transformation in physics is to come—

from space and time as absolute givens to reality as a participatory informational process—then our funding systems must evolve accordingly. Science must once again become a place where new ideas can breathe, before they are measured.

VIII. Conclusion: A Call for Intellectual Recalibration

The Wheelerian Foundation Initiative emerges not from opposition to current scientific achievements, but from a deep recognition that the most significant discoveries in physics have always come from questioning the foundations, not from polishing the surface. As we enter an era marked by extraordinary technological capability, global instability, and increasing philosophical disorientation, the need to re-engage with the most basic questions of existence—*What is reality made of? What is the role of observation? Can space, time, and matter be derived from something deeper?*—has never been more urgent.

Why Foundational Questions Matter More Now Than Ever

Science is often perceived as a cumulative enterprise—each result building upon the last, drawing us closer to a complete picture. But history shows that true breakthroughs come from paradigm shifts, from moments when accepted assumptions are overturned, and new ways of thinking emerge. Today, physics finds itself in a situation not unlike that of the early 20th century, before the advent of relativity and quantum mechanics: deeply successful in its predictions, but profoundly incomplete in its explanations.

The split between General Relativity and Quantum Mechanics is not a minor technical mismatch—it is a rift in the conceptual fabric of physics. One theory describes gravity and the geometry of the universe; the other governs the behavior of the very building blocks of matter. No existing framework reconciles the two. And yet, instead of investigating the origin of this disjunction, the scientific community continues to channel its greatest resources into increasingly complex confirmations of classical or semi-classical theories.

At a time when artificial intelligence, quantum computing, and information theory are rapidly transforming our intellectual landscape, we must return to the foundations of physical law—not to rehash old debates, but to create the space for new principles to emerge.

The Urgency of Exploring the Quantum Fabric Over Refining Classical Frameworks

The pursuit of precision within established paradigms, while valuable, has reached diminishing returns in terms of conceptual insight. Instruments like the Einstein Telescope promise new astrophysical data, but are unlikely to illuminate the deeper ontological structures from which those data arise. If we continue to ask only the questions we already know how to ask, we will continue to receive the answers we already expect.

Instead, we must turn our attention to the quantum substrate of reality—to the vacuum fluctuations, the entangled states, the measurement paradoxes, and the informational structures that suggest a universe far stranger than any geometric model can capture. We must ask what space and time are, not just how they behave. We must investigate the role of the observer, not just the output of the measurement. We must treat quantum noise not as disorder, but as the grammar of emergence.

The Wheelerian Initiative proposes that this exploration is not only timely but necessary. It offers a path toward redefining the terms of inquiry, where reality is not a fixed object to be observed but a dynamic process in which we participate.

An Open Invitation to Funders, Institutions, and Scientists to Embrace the Unknown

This document is not a blueprint; it is a call to action. A call to funders to invest in possibility over certainty. A call to institutions to support intellectual risk over incremental prestige. A call to scientists—especially the next generation—to reclaim the spirit of wonder that first drew humanity to the stars and to the atom.

We do not claim to know where this path will lead. But we assert, with clarity and confidence, that the current path—one of escalating scale, cost, and conformity—cannot by itself lead to the unification of physics or the next revolution in understanding. If we are to take the next leap, we must be willing to look beneath the known, to question the deepest assumptions of what reality is.

The Wheelerian Foundation Initiative stands as a platform for this recalibration. It is not a rejection of science—it is its renewal. It is not a break with tradition—it is a return to its most vital tradition: the courage to ask questions that no one yet knows how to answer.

Let us build a science not only of facts, but of first principles. Let us explore not just what the universe does, but what it is. And let us do so together—across disciplines, institutions, and borders—with the humility to admit what we do not know and the resolve to find out.

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Appendix A: Key Experiments in Wheelerian Physics

This appendix outlines a set of experiments that exemplify the Wheelerian approach—experiments that probe the interface of observation, information, and reality. These form the empirical backbone of the Initiative's experimental agenda and demonstrate the kinds of results that challenge classical assumptions about causality, determinism, and objectivity.

1. Casimir Effect Measurement Enhancements
    - Ultra-precise measurements of vacuum-induced forces between conducting plates at nanometer scales. These provide direct probes of zero-point fluctuations and may help test theories of structured quantum vacuum.
2. Delayed-Choice Quantum Interference
    - Refined versions of Wheeler's delayed-choice experiment, where the decision to measure a particle's wave or particle behavior is made after it has entered an interferometer. This challenges classical notions of temporality and retrocausality.
3. Quantum Eraser with Entangled Photons
    - Experiments where "which-path" information is erased after detection, showing that entanglement correlations depend not only on measurement but on the context of information availability.
4. Weak Measurement Probes
    - Low-disturbance measurements of quantum systems to track intermediate states without full collapse. May provide insight into the transition from quantum potentiality to classical actuality.
5. Vacuum Fluctuation Imaging
    - Use of squeezed light and quantum tomography to reconstruct spatial-temporal properties of vacuum noise. Useful in understanding the informational structure of quantum fields.

6. Quantum Simulation of Pre-Spacetime Models
    - Implementing artificial quantum systems (e.g., with ultracold atoms or trapped ions) to model how space or causality might emerge from entanglement patterns and logical operations.

Appendix B: Notable Historical Precedents

This appendix summarizes pivotal conceptual and experimental moments that paved the way for a Wheelerian approach to physics. These precedents inform both the philosophical underpinnings and the empirical possibilities of the initiative.

1. Wheeler's Delayed-Choice Thought Experiment (1978)
    - Argued that the act of measurement retroactively determines the behavior of quantum systems, suggesting a participatory rather than passive universe.
2. Feynman Path Integrals (1948–)
    - The notion that particles explore all possible paths until observation collapses the wavefunction aligns with Wheeler's view of potentiality and measurement.
3. Bell's Theorem and Aspect Experiments (1964–1982)
    - Demonstrated that local realism is incompatible with quantum mechanics, reinforcing the non-classical, holistic view of the universe that Wheeler anticipated.
4. Quantum Zeno Effect
    - Shows that observation can "freeze" the evolution of a quantum system—an experimental window into the role of measurement in shaping outcomes.

5. Quantum Eraser (Kim et al., 2000)
    - A real-world implementation of Wheeler's ideas, this experiment reveals that the choice to preserve or erase information affects correlations, even after the detection event.
6. Digital Physics & Cellular Automata (Zuse, Wolfram)
    - These models explore the idea that the universe operates as an information processor, echoing Wheeler's "It from Bit" hypothesis.

Appendix C: Draft Budget Scenarios

This appendix presents sample budget models to illustrate the relative affordability and scalability of the Wheelerian Foundation Initiative compared to traditional large-scale scientific projects.

Scenario 1: Baseline Pilot Program (3 years, single center)

- Experimental lab setup (quantum optics, vacuum measurement): €2M
- Core research team (6 researchers + admin): €1.8M
- Visiting scholar program & fellowships: €600K
- Conferences, workshops, dissemination: €300K
- Overhead and equipment maintenance: €300K
  Total: €5M

Scenario 2: Distributed Network of 5 Labs (5 years)

- Five small experimental sites across Europe, Asia, and North America
- Coordinated research agenda + open-access repository
- Shared software infrastructure and cloud-based simulation tools
  Total: ~€20–25M

Scenario 3: Full-Scale Research Ecosystem (10 years)

- Two dedicated Wheelerian Research Centers
- Dozens of early-career challenge grants and international fellowships
- Experimental and theoretical integration with existing institutions
- Global open-access archive for data and simulation sharing
  Total: ~€60–75M

These costs are dramatically lower than those of mega-projects like the Einstein Telescope, allowing far greater diversity of intellectual investments and lower risk per hypothesis tested.

Appendix D: Recommended Reading and Research Networks

This appendix offers a curated set of references and collaborative organizations relevant to Wheelerian foundational research. These resources span physics, philosophy, computer science, and interdisciplinary frameworks that align with the goals of the initiative.

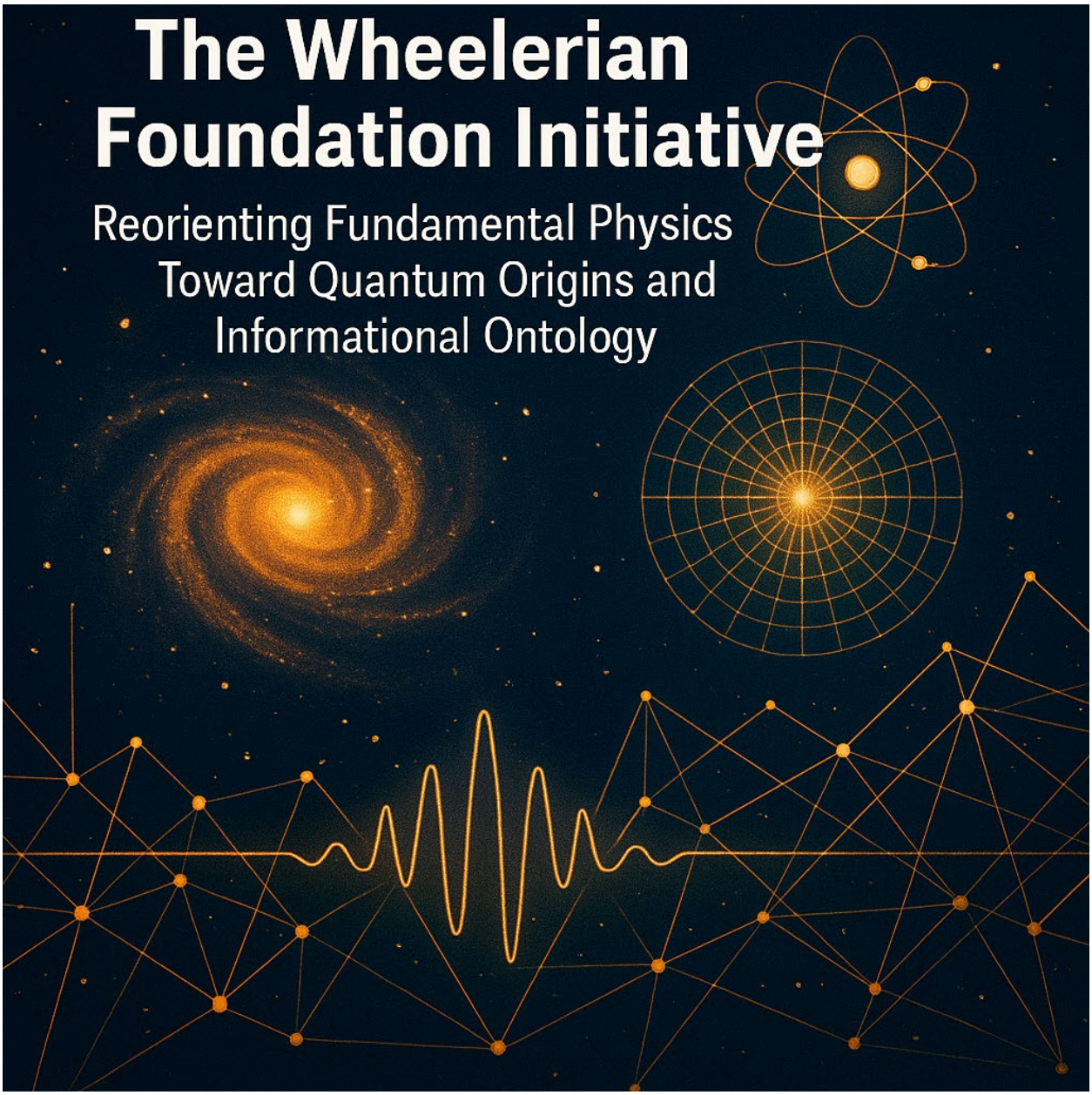
Key Texts and Articles:

- John Archibald Wheeler, *At Home in the Universe* (1994)
- John Wheeler and Wojciech Zurek (eds.), *Quantum Theory and Measurement* (1983)
- Anton Zeilinger, *Dance of the Photons* (2010)
- David Deutsch, *The Fabric of Reality* (1997)
- Huw Price, *Time's Arrow and Archimedes' Point* (1996)
- Seth Lloyd, "Programming the Universe" (2006)
- Gerard 't Hooft, "Determinism and Quantum Mechanics" (various)

Research Networks and Institutes:

- Foundational Questions Institute (FQXi) – Supports unconventional foundational research in physics and cosmology.
- Perimeter Institute for Theoretical Physics – A leading center for quantum foundations and emergent spacetime research.
- Santa Fe Institute – Interdisciplinary research into complexity, emergence, and information theory.
- Centre for Quantum Technologies (CQT), Singapore – Research in quantum information and computation.
- Vienna Institute for Quantum Optics and Quantum Information (IQOQI) – Experimental research aligned with Wheelerian goals.
- John Templeton Foundation – Funding source for fundamental inquiries at the intersection of science and philosophy.

These texts and networks constitute a growing ecosystem of thinkers and institutions prepared to engage the next generation of fundamental questions—questions not about how the universe behaves, but about why there is a universe to behave at all, and how it arises from information, participation, and process.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